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NITROGENOUS FERTILIZERS OBTAINABLE IN THE UNITED STATES.

By

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INTRODUCTION.

Present agricultural practice requires that nitrogenous matter be supplied to the soil supporting crop growth. At one time it was the belief that all the nitrogen found in the substance of the plant had its origin in that added to the soil as a fertilizer. Now, however, it is definitely known that this is by no means true in the case of certain types of plants and that the uncombined nitrogen of the atmosphere is made available for plant metabolism through the instrumentality of lower organisms inhabiting the soil. The marked accumulation of nitrates in certain soils of Colorado has been explained on the basis of the bacterial fixation of atmospheric nitrogen.[1] Nitrogen combined as nitrate of soda occurs naturally in the arid plateau region of Chile. It also occurs in certain of the rainless portions of the United States. In this country, however, it occurs as so small a proportion of its carrier that its extraction therefrom under present conditions is commercially impracticable.[2] Aside from this occurrence, combined nitrogen is found in nature only in the complex compounds constituting the organisms of plants and animals or arising from the decomposition of these. In small amounts it is found in the soil in the form of certain organic compounds,[3] some of which are toxic in their action on growing plants, and some beneficial.

The nitrogenous compounds comprising animal and vegetable tissues constitute the principal foods for man and animals. In general it is true, therefore, that only in those instances where their occurrence is such as to preclude their ready marketing or where portions of them for one reason or another are unfit for food, are they available for fertilizer purposes. There is one striking exception to this generalization. In the destructive distillation of coal for the preparation of gas and coke the nitrogen present in the coal is evolved, in part at least, as ammonia. This is easily recoverable and in the form of ammonium salts constitutes an important source of nitrogen for fertilizer purposes.

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[1] Headden, Colo., Agr. Expt. Sta., Bulls. Nos. 155 and 160.

[2] Free, Report of a Reconnoissance of the Lyon Nitrate Prospect near Queen, New Mexico, Circ. No. 62 Bureau of Soils, U. S. Dept. Agr.; Gale, U. S. Geol. Survey, Bull. 523, 1912.

[3] Bulls. Nos. 53, 70, 74, 77, 83, 87, Bureau of Soils, U. S. Dept. of Agr.

The agronomic necessity which compels the use of nitrogenous fertilizers and the scarcity of nitrogenous compounds available for fertilizer purposes together make the nitrogen carriers of extremely great importance.

The following materials constitute the present source of nitrogenous fertilizers:

Chile saltpeter, or nitrate of soda.
Artificial nitrates of soda, lime, and ammonia.
Sulphate of ammonia.
Fish scrap.[1]
Tankage.
Dried blood.
Cottonseed meal.

SODIUM NITRATE.

Sodium nitrate occurs naturally as an impregnation of earthy and saline material, known as caliche, on certain of the arid uplands of the Provinces of Tarapacá, Tacna, Antofagasta, and Atacama, in Chile. The names "Chile niter" and "Chile saltpeter" have been given this product because of its occurrence.

The composition of caliche is given in Table I.[2]

TABLE I.—*Analysis of caliche from Tarapacá Province, Chile.*

Constituent.	Proportion.	Constituent.	Proportion.
	Per cent.		*Per cent.*
Sodium nitrate	60.97	Calcium sulphate	1.33
Sodium iodate	.73	Magnesium sulphate	5.88
Sodium chloride	16.85	Insoluble	4.06
Sodium sulphate	4.56	Water	5.64

PRODUCTION AND CONSUMPTION OF SODIUM NITRATE.

Of the sodium nitrate produced by the Chilean beds during the year 1911, 2,419,700 tons were exported, 1,827,089 tons to European countries[3] and 518,613 tons to the United States. In the United States 70,000 tons of this were used in agriculture.

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[1] For a discussion of fish scrap see Bull. No. 2, U. S. Dept. Agr., "The Fish-scrap Fertilizer Industry of the Atlantic Coast."

[2] Pennock, Losses of Combined Nitrogen. J. Ind, Eng. Chem. 4, 172 (1912).

[3] Exportations to Egypt are included in this amount.

In 1910, 535,820 tons of sodium nitrate were imported. The distribution of this among the various industries is shown in Table II.[1]

TABLE II.—*Consumption of sodium nitrate by the various industries in the United States in the year 1910.*

Use.	Proportion.	Use.	Proportion.
	Per cent.		*Per cent.*
Manufacture of fertilizer	13	Explosives	41
Manufacture of dystuffs	12	Nitric acid	9
General chemistry	10	Sulphuric acid	6
Glass	4	Unaccounted for	5

In past years the amount of nitrate of soda was so much in excess of that of any other nitrogenous ingredient of artificial fertilizers that the world has been regarded as being dependent on nitrates for its supply of these. The more intensive agriculture of recent years has emphasized the demand for nitrates. Their use has increased at such a rate that the beds have been threatened with exhaustion. However, the demand for nitrogen carriers has served not only to increase the output of natural nitrates, but likewise has stimulated the manufacture of other nitrogenous substances suitable for fertilizer manufacture, so that the world's dependence on Chile is yearly growing less. In fact, during the year 1912 there was a marked falling off in the nitrate trade, there being an enormous substitution of other nitrogen carriers for nitrates. This falling off is said by the producers to be due in large measure to high freight rates and to labor difficulties at the deposits.[2]

During the last few years the Chilean beds of nitrates have been surveyed and figures have been obtained which make possible a fairly close estimate of the amount of nitrate remaining there. This is in itself immense, but at the recent rate of increase of consumption the supply is destined to exhaustion in a few generations. Since the report of these estimates, however, it is claimed that there have been certain improvements in the methods of extraction which admit of a more perfect recovery of the nitrates.

The surveys of those parts of the United States whose climatic conditions are such as to admit of the accumulation of nitrates have failed to reveal their presence in workable quantities.[3]

Sodium nitrate in its pure condition is a colorless, crystalline substance. The commercial nitrate contains 15.5 per cent of nitrogen.[4]

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[1] Pennock, loc. cit.

[2] Cf. American Fertilizer, 28, 22, (1913).

[3] Circ. No. 62, Bureau of Soils, U. S. Dept. Agr.; Bull. No. 523, U. S. Geol. Surv., 1912.

[4] Voorhees, Commercial Fertilizers, Farmers' Bulletin No. 44, U. S. Dept. Agr.

SULPHATE OF AMMONIA.

Bituminous coal contains 1.2 to 1.34 per cent of combined nitrogen. In the destructive distillation of coal for the production of coke 33 per cent of this nitrogen is evolved, as shown in Table III.[1]

TABLE III.—*Nitrogen from the production of coke.*

Form in which nitrogen is evolved.	Amounts.	Form in which nitrogen is evolved.	Amounts.
	Per cent.		*Per cent.*
Remaining in the coke	63.7	In tar	2.9
Recoverable as ammonia	20.3	Recoverable as pyridine	.25
As elementary nitrogen in gas	8.1	Recoverable as cyanide	.3

Other volatile substances, carbonaceous in character, are, of course, given off, such as gas of high calorific value, coal tar, benzol, etc., and constitute the main distillation products.

In Table IV the nitrogen of a ton of coal and products resulting from the distillation of that weight have been calculated to pounds of ammonium sulphate.[2]

TABLE IV.—*Nitrogen per ton of coal and products produced from distillation of a ton of coal.*

Constituent.	Ammonium sulphate per ton of coal.	Constituent.	Ammonium sulphate per ton of coal.
	Pounds.		*Pounds.*
Coal, 1.3 per cent nitrogen	122.6	Nitrogen in pyridine	0.3
		Nitrogen in cyanide	.4
Ammonia yield	25.0		
Nitrogen left in coke	78.2	Total	119.4
Nitrogen in 10,000 cubic feet of gas	12.0	Unaccounted for	3.2
Nitrogen in tar (90 pounds per ton)	3.5		

In the main, coal is distilled in this country in that form of coke oven, the beehive oven, which does not admit of the recovery of the distillation products. Instead, they are allowed to go to waste. So we are indebted to the by-product recovery oven for the main supply of ammonium sulphate. The amount recovered is valued at about $4,000,000, while the recoverable ammonia annually destroyed in the coking processes by the beehive ovens is valued at $22,000,000.[3]

In the manufacture of producer gas by the Mond process, where the distillation takes place in the presence of steam, 80 pounds of ammonium sulphate are obtained per ton of coal. This is four times as much as that obtained from an equal weight of coal in the retort process.

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[1] Pennock, J. Ind. Eng. Chem., 4, 174 (1912).

Pennock, loc. cit.

[3] Parsons, Hearst's Magazine, January, 1913, p. 128.

It has been said that since coal will never be distilled for the sake alone of the ammonia which its distillation liberates, the increase in the output of ammonium sulphate will depend on the increase in coal distillation. The inference is that the increase in ammonia production with the increase in the coke industry will be in the same ratio of ammonia to coke as exists in the industry to-day. This probably will not prove to be the case, owing to the replacement of the old form of oven by the by-product recovery type, both in old plants and in those undergoing erection.

At the beginning of 1912 there were 4,624 by-product coke ovens in operation in the United States and 698 building. These were distributed as shown in Table V.

TABLE V.—*Number and location of by-product coke ovens in the United States.*

Location.	Number of ovens.	Number of ovens building.	Location.	Number of ovens.	Number of ovens building.
Alabama	340	280	New York	556	0
Illinois	480	48	Ohio	174	0
Indiana	540	70	Pennsylvania	1,292	300
Maryland	200	0	West Virginia	120	0
Massachusetts	400	0	Wisconsin	160	0
Michigan	162	0			
Minnesota	50	0	Total	4,624	[1] 698
New Jersey	150	0			

[1] Quoted from American Fertilizer, **38**, 32 (1913).

During the year 1912 about 155,000 short tons of ammonium sulphate were produced in the United States. In the same length of time the United States imported about 60,000 tons, making a total consumption of ammonium sulphate in this country of about 215,000 tons.

The annual production for the United States for the last five years is given in Table VI.[1]

TABLE VI.—*Production of ammonium sulphate in the United States, 1908 to 1912.*

Year.	Production.	Year.	Production.
	Tons.		*Tons.*
1908	83,400	1911	127,000
1909	106,500	1912	155,000
1910	116,000		

From this table it will be seen that the output for 1912 exceeds that for 1911 by 28,000 tons, while the increase for the preceding year was only 11,000 tons. It may be observed further that the domestic output has almost doubled during the five years.

The world's production of ammonium sulphate in 1911 had reached the total of 1,187,000 tons. This, on the basis of a nitrogen content of 20.5 per cent, is equivalent to 243,335 tons of nitrogen. The amount of nitrate of soda, 2,490,121 tons, shipped from Chile that year, on the basis of a nitrogen content of 15 per cent, is equivalent to 373,500 tons of nitrogen. Of the total amount of nitrogen obtained from Chile niter and ammonium sulphate, that from niter is equal to 60 per cent of the whole and that from ammonium sulphate 40 per cent. Since more of the former than of the latter is used for purposes other than agricultural, it is probable that the production of nitrogen for fertilizer purposes from coal distillation is greater than that from the Chile nitrate beds. If this is not true at present, it is expected that the increased use of the by-product coke oven shortly will bring it to pass.

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[1] Quoted from American Fertilizer, loc. cit.

The world's output in ammonium sulphate during 1912 is given by countries in Table VII, in which the United States appears third in point of output.[1]

TABLE VII.—*World's production of ammonium sulphate, 1912.*

Country.	Production.	Country.	Production.
	Tons.		*Tons.*
Germany	465,000	Belgium	49,500
England	379,000	Spain, Italy, other countries	170,000
United States	155,000		
France	68,500	Total	1,287,000

Ammonium sulphate as a stimulator of plant growth compares favorably with sodium nitrate. While it is generally believed that the nitrate of soda is more immediately available for plant assimilation than the sulphate of ammonia, the two give practically the same results as fertilizers. The sulphate possesses a slight advantage in being a somewhat more nitrogenous body than the nitrate, containing 20 per cent nitrogen against the 15 per cent contained by the nitrate.

The development of the ammonium-sulphate industry is possible in two directions: In the displacement of beehive ovens by by-product recovery ovens, and in the development of the coking industry, with the utilization, of course, of the by-product ovens. There is no good reason, should the fertilizer industry demand it, why the entire amount of ammonia now thrown away annually in the coking industry should not be rendered available. In addition to these two particulars in which the production might be increased mention should be made of other possible sources of ammonia which have been suggested, such as the distillation of oil shales, peat, garbage, and the sludge obtained in sewage-disposal plants.

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[1] Cf. J. Ind. Eng. Chem., **5**, 253 (1913).

Baskerville,[1] with reference to oil shales, has shown[2] that "the principal by-product on retorting (under suitable conditions), ammonium sulphate, will often more than bear the expense of mining and treatment." This author reports an oil shale from Montana which yields 41.5 pounds ammonium sulphate and 6 gallons crude oil per short ton.

In the dry distillation of peat most of its nitrogen is evolved uncombined. On the other hand, by the adaptation of the Mond process of distillation as much as 110 pounds ammonium sulphate per ton of peat may be obtained.

Recently proposed methods of synthesizing ammonia from atmospheric nitrogen are undergoing commercial exploitation and give promise of success.

ARTIFICIAL NITRATES.

The recent rapid development in the manufacture of nitric acid by the electrothermal fixation of atmospheric nitrogen has made artificial nitrates commercially important.

Three well-known processes are employed in the direct oxidation of nitrogen to oxide—the Birkeland-Eyde, the Schönherr, and the Pauling—the processes differing chiefly in the design of the electric furnace and plant installation rather than in the chemical reactions involved.

It is claimed that the Birkeland-Eyde process of manufacture yields 500 to 550 kilograms of nitric acid or 850 to 940 kilograms of calcium nitrate for every kilowatt-year of electrical energy expended. The Norwegian hydro-electric nitrogen companies now are utilizing about 200,000 horsepower in the manufacture of nitrates and nitrites.

The composition of commercial calcium nitrate, manufactured by the Birkeland-Eyde process, is given in Table VIII.[3]

TABLE VIII.—*Analysis of commercial calcium nitrate.*

Constituent.	Proportion.	Constituent.	Proportion.
	Per cent.		*Per cent.*
Calcium oxide	25.83	Magnesium oxide	0.41
Nitrogen	12.47	Aluminum oxide	.71
Water	23.83	Insoluble (in hydrochloric acid)	.51
Carbon dioxide	.52		

During the year 1910, 13,531 tons calcium nitrate were exported from Norway. This is in addition to 2,000 tons calcium nitrate which, it is estimated, is the domestic consumption for fertilizer purposes. In the same year, 3,200 tons sodium nitrite and 1,074 tons sodium nitrate were exported. The total production of nitrates, calculated to a basis of calcium nitrate, is equivalent to about 22,000 tons. During the year 1911, 2,302 tons calcium nitrate were imported into the United States.[1]

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[1] American Oil Shales, J. Ind. Eng. Chem., **5**, 73 (1913).

[2] Proc. Seventh Internat. Cong. Appl. Chem., 1910, Sec. IV; J. Ind. Eng. Chem., **1**, No. 8 (1909).

[3] Manufacture of Nitrates from Air, Scott, J. Roy. Soc. Arts, **60**, 645 (1912).

CALCIUM CYANAMIDE.

Calcium cyanamide is perhaps the most nitrogenous material manufactured for fertilizer purposes. It is prepared from calcium carbide and free nitrogen, the latter being prepared from the atmosphere by the removal of oxygen. The reaction between the two substances may be represented by the following equation:

$$\underbrace{CaC_2+N_2}_{\text{Calcium carbide}} = \underbrace{CaCN_2+C}_{\text{Calcium cyanamide}}$$

The product is a gray powder. In addition to nitrogen it contains a high percentage of calcium and some finely divided carbon. In the soil it reacts with water to produce urea and lime, the former being acted upon further to form ammonia.

TABLE IX.—*Installations for manufacture of calcium cyanamide by the Frank and Caro process.*

Name of company.	Place of installation.	Output per annum.
		Tons.
Nitrogen Fertilisers Co. (North-Western Cyanamide Co.)	Odda, Norway	15,000
Do	Alby, Sweden	15,000
Società Italiana de Prodotti Azotate	Piano d'Orto, Italy	4,000
Società Italiana per il Carburo de Calcio	Terni, Italy	15,000
Società Piemontese per il Carburo de Calcio	San Marcel, Italy	3,000
Société Française pour les Produits Azotes	Martigny, Switzerland	7,500
Do	Notre Dame de Briancon	7,500
Bayerische Stickstoff Werke	Trostberg, Bavaria	15,000
Öst-Deutscher Stickstoffcale und Chemische Werke	Bromberg, Prussia	2,500
A. G. Stickstoffdunger	Knapsack, Germany	18,000
Società per l'Utilizzazione della Forze Idrauliche della Dalmazia.	Selenico, Dalmatia	4,000
Do	Dugirat, near Almissa	80,000
Japanese Nitrogen Products Co	Kinzei, near Osaka	4,000
American Cyanamide Co	Nashville, Tenn	4,000
Do	Niagara	12,000

The composition of commercial calcium cyanamide is given in Table X.[2]

TABLE X.—*The composition of commercial calcium cyanamide.*

Constituent.	Proportion.	Constituent.	Proportion.
	Per cent.		*Per cent.*
Calcium cyanamide ($CaCN_2$)	45	Iron and aluminium oxides	2
Calcium carbonate ($CaCO_3$)	4	Silica (SiO_2)	2
Calcium hydroxide ($Ca(OH)_2$)	27	Combined water	4
Calcium sulphate ($CaSO_4$)	1	Free moisture	1
Carbon (free)	14		

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[1] Morton, "Utilization of Atmospheric Nitrogen," Bull. Dept. Commerce and Labor, Special Agent Series No. 52.

[2] Pranke, J. Ind. Eng. Chem., **5**, 159 (1913).

Concerning the future of the cyanamide industry, Mr. E. J. Pranke, under date of November 15, 1912, says:[1]

> The cyanamid industry is undoubtedly only in its infancy. At present there are four factories in Germany, four in Italy, two in France, and one each in Austria, Norway, Sweden, Switzerland, Japan, and America. The American Cyanamid Co. built its first plant at Niagara Falls, Ontario, in 1909, beginning commercial manufacturing January 18, 1910. Additions to the plant, which will be completed in March, 1913, will give a capacity of 25,000 tons per annum, and by the end of the year the full productive capacity of the company, including the extension now under way, should be 50,000 tons per annum.

TANKAGE AND DRIED BLOOD.

Tankage is a product from the abattoirs, consisting of the waste materials, such as bones, horns, hoofs, hair, the trimmings of hides, and some blood. After treatment for the recovery of glue the mass is dried and ground and then sold for fertilizer purposes. As the proportions in which these ingredients enter vary, the composition of tankage varies widely. Its nitrogen content is said to vary between the values of 5 and 8 per cent, and its phosphoric acid content between the values of 5 and 12 per cent. Some of the nitrogen of tankage is regarded as unavailable, by which is meant that it is present as a part of nitrogenous matter which is more resistant to the agencies of decay and therefore is only slowly available. The composition of tankage and also the variation in its composition are shown in Table XI, being analyses of three samples from a single abattoir.[2]

TABLE XI.—*Analyses of three samples of tankage from a single abattoir.*

Ingredient.	First year.	Second year.	Third year.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10.5	9.8	10.9
Nitrogen	5.7	7.6	6.4
Phosphoric acid	12.2	10.6	11.7

Dried blood is perhaps the richest in nitrogen of all the organic materials used in the fertilizer industry. Unadulterated blood when quite dry contains 14 per cent of nitrogen, but as obtained on the market its content of that element varies from 9 to 13 per cent.

For a statement of the present output of these materials we are indebted to Mr. F. S. Lodge, who has compiled certain data for use in this paper. In his estimates he makes the assumption, based on observation, that each beef animal in good practice yields 12 pounds of dry tankage and 7 pounds of dried blood; each calf, 2.4 pounds tankage and 0.75 pound blood; each hog, 4.8 pounds tankage and 1.2 pounds blood; and each sheep, 1.2 pounds tankage and 0.5

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[1] J. Ind. Eng. Chem., 5, 159 (1913).

[2] Snyder, Soils and Fertilizers (1908), p. 149.

pound dried blood. These figures do not include bone or concentrated tankage from tank water.

From the figures estimated by the Bureau of Animal Industry as representing the total slaughter of cattle, calves, swine, and sheep in the United States, in 1912, it has been calculated that if all the materials rendered available by this slaughter had been saved and converted into tankage and dried blood they would have produced 222,535 tons of tankage and 79,794 tons of dried blood.

The present supply of tankage and dried blood depends largely on the output of the large packing houses, as the waste from the smaller ones is not so available for use as fertilizer. An increase in the output of these materials depends on the growth in size and number of the large abattoirs and the more complete utilization of the waste from the smaller slaughterhouses. The chances for any considerable development in the former manner are considered rather remote, owing to the settling of lands formerly devoted to the grazing of cattle. With regard to the latter manner of increase speculation perhaps is idle. All things considered, it may be said that the chances for any large immediate increase in the supply of tankage and dried blood appear rather poor.

In this connection it should be pointed out that in Denmark country killing is being practiced on a cooperative basis in small community abattoirs, with the careful preservation of all the blood and much of the tankage. The introduction of this system among American agriculturists undoubtedly would result in the increased output of both blood and tankage and should render available for fertilizer and feeding purposes the greater proportion of the 75 per cent of these products created in country killing and now permitted to go to waste.

TABLE XII.—*Estimated slaughter of cattle, swine, and sheep during the fiscal year of 1912.*

[Estimate by Bureau of Animal Industry.]

Slaughter.	Cattle.	Calves.	Swine.	Sheep and lambs.
Wholesale	7,500,000	2,300,000	43,000,000	12,500,000
Retail and farm	5,000,000	3,700,000	23,000,000	2,500,000
Total	12,500,000	6,000,000	66,000,000	15,000,000

In deriving the estimate of yield of tankage and blood from the slaughter represented by the above figures it was assumed that all the tankage and blood were saved from the animals killed by wholesale and 25 per cent of that from the retail and country killed. It is believed that the former estimate is too great and that not all of the tankage and blood obtainable from the wholesale slaughter is saved, though the greater proportion of this surely is saved. For the amount saved from the country-killed animals Mr. Lodge's estimate of 25 per cent is accepted.

The figures obtained from Mr. Lodge were derived from the census figures for the slaughter in 1909 and the ratio of animals on the market in 1909 to those in 1912. This gave a number representing the slaughter of 1912. The actual kill during 1912 at the 11 big stock markets of the country, viz, Chicago, Kansas City, Omaha, St. Louis, St. Joseph, Sioux City, St. Paul, Indianapolis, Milwaukee, Oklahoma City, and Pittsburgh, is known definitely. The resulting figures are given in Table XIII.

TABLE XIII.—*Number of cattle, swine, and sheep slaughtered during the calendar year 1912.*

[Estimate by Mr. F. S. Lodge.]

Slaughter.	Cattle.	Calves.	Swine.	Sheep and lambs.
Total in 11 principal markets (determined)	5,259,881	1,005,290	18,518,872	10,793,692
Retail and farm	2,043,493	1,248,966	18,738,803	6,364,013
Total (estimated)	7,303,374	2,254,256	37,257,677	17,157,705

Knowing the waste attending the slaughter of the food animals in other than the thoroughly organized abattoirs, it is believed that the figures for tankage and blood produced at the 11 principal markets represent pretty closely the total production in these, and that, accordingly, the estimates of Mr. Lodge more closely approximate the actual production of tankage and blood than do the estimates from the figures furnished by the Bureau of Animal Industry.

RÉSUMÉ.

In the appended table is given the consumption in the United States of the various nitrogenous substances employed in mixed fertilizers. From the percentage of their nitrogen content is calculated the amount of nitrogen yielded by them. These values are given in the third column of figures. A true basis of comparison is thus obtained, and the relative importance of the different nitrogenous ingredients of commercial fertilizers may be seen.

The figures for ammonium sulphate may be large, as they are made up of the total production of the United States, 155,000 tons, plus the total importation, 60,000 tons, without regard to the proportion of this substance used for other purposes than for fertilizer. The figure for sodium nitrate is obtained by taking 13 per cent, the proportion which enters fertilizers, of the total annual importation, 535,820 tons. This may be somewhat low, as 5 per cent of the importation is unaccounted for, a part of which may be used in the fertilizer industry.

Two sets of figures are given for tankage and blood. They are based on the respective estimates of the slaughter in the United States by the Bureau of Animal Industry and Mr. F. S. Lodge. The Bureau of Animal Industry derived their estimate of the slaughter partly from the number of animals killed under Government inspection, which they regard as 60 per cent of the total wholesale slaughter. Their estimate is given in detail in Table XII.

An error may have been introduced in the figures for nitrogen yielded by tankage and blood by taking the wrong value to represent the percentage composition of these in nitrogen. Their composition is quite variable: a figure was taken which, it was believed, justly represented the average content in nitrogen.

TABLE XIV.—*Sources of nitrogen used in mixed fertilizers of the United States.*

Material.		Amount used in United States.	Nitrogen content.	Nitrogen yielded.
		Tons.	*Per cent.*	*Tons.*
Ammonium sulphate		215,000	19.75	42,463
Sodium nitrate (Chilean)		70,000	15.5	10,850
Calcium nitrate (artificial)			12.75	
Calcium cyanamid		11,264	18.0	2,028
Cottonseed meal			6.5	
Tankage	Bureau of Animal Industry	161,950	6.5	10,527
	Lodge	99,324		6,456
Fish scrap		70,000	9.0	6,300
Dried blood	Bureau of Animal Industry	57,473	11.0	6,322
	Lodge	37,710		4,148

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[illegible]		[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	
Tankage	Bureau of Animal Industry	[illegible]	[illegible]	[illegible]
	Lodge	[illegible]		[illegible]
Fish scrap		[illegible]	[illegible]	[illegible]
Dried blood	Bureau of Animal Industry	[illegible]	[illegible]	[illegible]
	Lodge	[illegible]		[illegible]